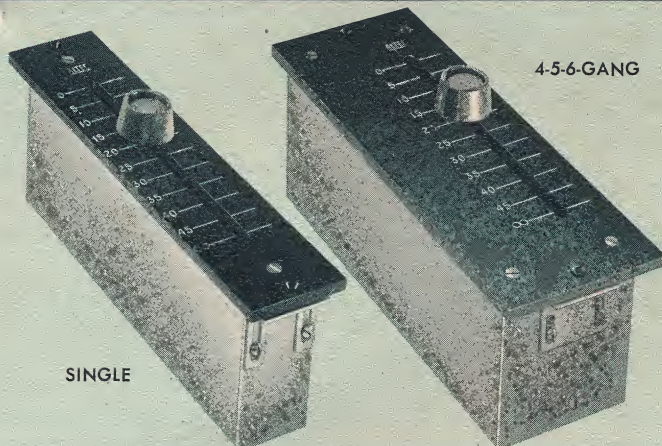
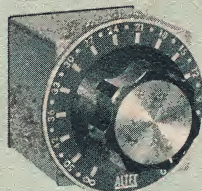


ALTEC ATTENUATORS



SINGLE

4-5-6-GANG



SINGLE



2-GANG



3-GANG

FEATURES:

Smooth Action

Fine (Pure) Silver Contacts
To Prevent Oxidation

Less Than One Milliohm
Contact Resistance

Easy, Accurate Control

Precise Attenuation

Compact, Space-Saving Size

Models for Every Purpose

Low Noise Operation

Long, Trouble-Free Life

Basically, a variable attenuator is a resistive network used in audio transmission circuits to alter the signal level by a series of steps, raising or lowering the level of the program material within the working limits of the associated equipment.

Physically, a variable attenuator consists of a group of fixed resistor networks connected to a multi-contact switch in such a way that changing the position of the control will vary the signal in steps of predetermined increments. They may be made in many different circuit configurations — such as "L", "T", "H", ladder or potentiometer networks.

Altec has over 330 listed types of attenuators available in ten different categories. Modifications of listed types and custom models are available on special order. In the pages to follow are listings of Rotary Mixers, Straight Line Mixers, Calibrated Controls, Grid Control Potentiometers, V U Range Extenders, Precision Decade Attenuators, Precision Matching Networks, Precision Decade Resistors, Turntable Faders, and Stereo Pan Pots.

Descriptions, specifications and ordering information accompany the listing in each category. As a guide to the selection of the appropriate type of equipment for a specific application, Altec has prepared the following discussion regarding these units and their circuitry.

MIXERS — Mixers will reduce the signal level at a uniform rate for all frequencies; or it may be used to increase the signal — without discernable steps — from a point of infinite attenuation to the maximum level (a process commonly known as "fading-in") without any recognizable frequency discrimination or distortion. Calibrated attenuators also reduce the signal by steps, but they cut-off to infinity at the last step. This abrupt transition is undesirable for mixing purposes. Therefore, mixers are designed without that sudden "off" step. A mixer reduces the signal level by linear steps down to about 45 db, then rapidly tapers off to infinity. Smooth transition from one degree of attenuation to another is a major factor involved in the design of a mixer. The greater the number of steps within the unit, the smoother will be the mixing operation and the less noticeable will be the mixing process in the final product. A change in signal level of 1 db is almost imperceptible; a change of 1½ db may be detected but it is not noticeable. As a general rule, the sound industry regards 30 steps of 1½ db each as the standard for high quality rotary mixers.

Small, less expensive mixers usually are limited to 20 steps of 2 db each. Where price requirements are more critical than the quality specifications, such mixers will serve their purpose with good results.

Slide wire mixers, with attenuation steps of 0.1 db or less, have extremely smooth operation and are considered the best choice for use in music recording or other critical applications where the highest quality is required.

Precise regulation of orchestra sections and soloists for monaural work requires a huge collection of mixers. Two-channel stereo and multiplex requirements doubled the amount needed, and three-channel stereo more than triples the complexity of studio control consoles. In spite of the increased number of controls, horizontal expansion of the console has been limited by an important — although often overlooked — physical dimension: the length of the sound engineer's arm.

Rotary mixers average about 2 to 3 inches in diameter, and the control knobs will be about 4 inches apart on a standard console. At the rate of three mixers per foot, the horizontal console rapidly reaches that "arm's-length" limit. On the other hand, a straight line mixer requires only 1½ inches between mounting centers; a distance which permits installation of a full complement of controls for three-channel work within easy reach on a horizontal console. Also, it is possible for an adept engineer to operate two, three, or even more straight line mixers with one hand. The vertical position of the control knob on a straight line mixer indicates the position of the unit at a quick glance. For some effects, a rotary mixer may be "rolled" with the side of the engineer's hand, but straight line mixers not only can be faded rapidly, they can be "snapped" as well ... and with only one finger if necessary.

Where space and that "arm's-length" measurement are not considerations, rotary mixers may be preferred simply because the engineer is more familiar with their operation. However, straight line slide wire mixers not only provide smoother mixing (in 0.1 db or less increments), they also allow complete stereo consoles to be established in considerably less space; approximately 60 percent less.



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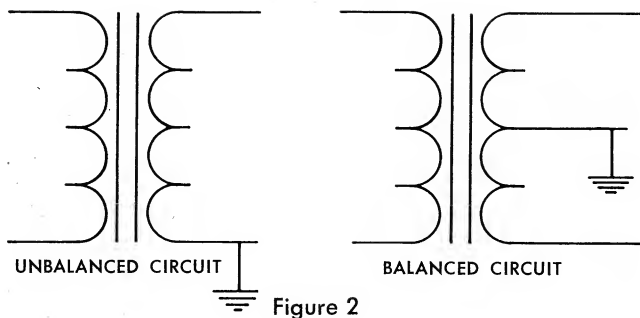
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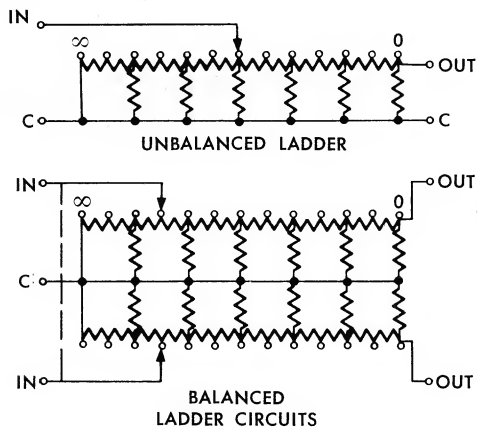
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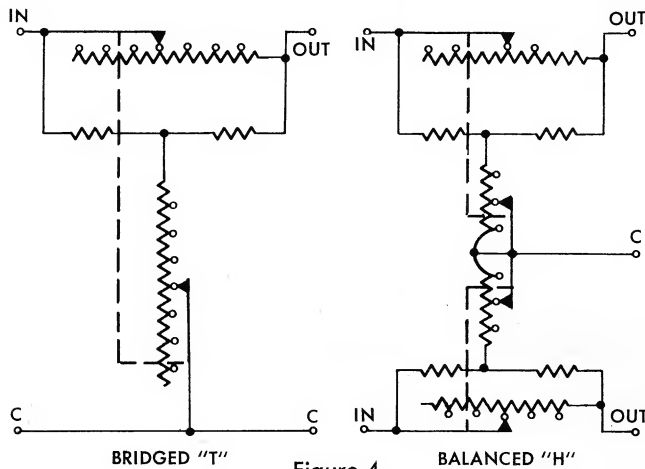
CIRCUIT TYPES

Attenuators are available in both unbalanced and balanced circuit configuration.

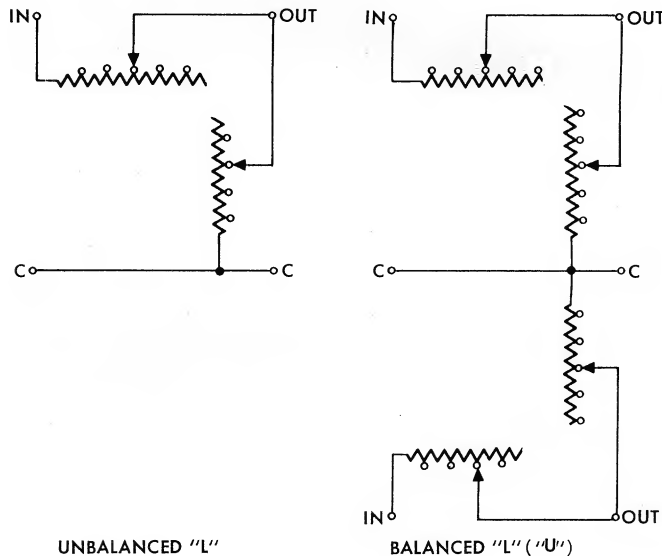
For mixer circuits and gain controls in consoles, unbalanced controls are recommended. An unbalanced circuit not only provides simplicity of design, but also is more economical than balanced circuitry. Balanced circuits are not practical in most applications because equalizers and other associated equipment usually is of the unbalanced configuration. Balanced circuitry is used where attenuators are to be inserted in long lines, or where leakage is a problem in measuring applications.



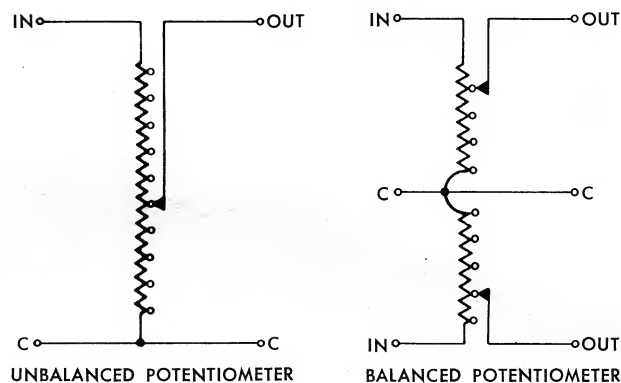
A LADDER CIRCUIT is the simplest and most common type used in mixers, and in attenuators which have extreme attenuation values. The circuits consist of a series of pi sections and the unit has only a single brush as compared with the two or more used in "T" circuit units.



The "T" CIRCUIT is an unbalanced attenuator which maintains constant input and output impedances. The circuit has no insertion loss and is used where precision attenuators are required. Essentially, a BALANCED "H" network consists of two opposing "T" circuits in which grounding is achieved in balanced lines. It is used in measuring devices and as a sub-master or master volume control where losses are to be minimized.



THE "L" CIRCUIT is used for loudspeaker controls — often as a level control in two-way speaker systems — and it is also used in the circuitry of some measuring devices.



POTENTIOMETERS may have either balanced or unbalanced circuits. They are voltage dividers and are used as level controls in grid circuits at impedances from as low as 500 ohms up to 50,000 ohms or even higher. The input level remains fairly constant, but the output may vary from zero to maximum. Where the first stages in an amplifier are push-pull, a balanced potentiometer should be used in the grid circuits.

SELECTING A MIXER

Ladder Versus "T"

For mixer applications, a ladder circuit usually is preferred over a "T" since the ladder allows virtually an infinite cut-off to about -120 db while the best that can be expected from the "T" is about -90 to -100 db. On the other hand, the last four positions of a 600-ohm ladder in a 30-step mixer will have a 30-percent drop in output impedance (to bring it to about 400 ohms). This mismatch effect, however, decreases in direct proportion to the number of units which are paralleled into the next circuit. With four or more units paralleled in a bank, the impedance mismatch all but disappears.

Another reason for the popularity of ladder circuits is that they provide 6 db of isolation between the preamplifier and the combining network. This isolation protects the mixer network in installations where the network follows the preamplifiers. Amplifiers which have feedback present low impedance looking back into the amplifier. Ladder circuits will prevent these amplifiers from shorting the mixer network.

Contact noise in a ladder circuit decreases in proportion to increased attenuation while it remains the same in a "T" circuit regardless of attenuation. Also, a "T" circuit requires double the circuitry and moving parts, a fact reflected in its higher cost and increased size.

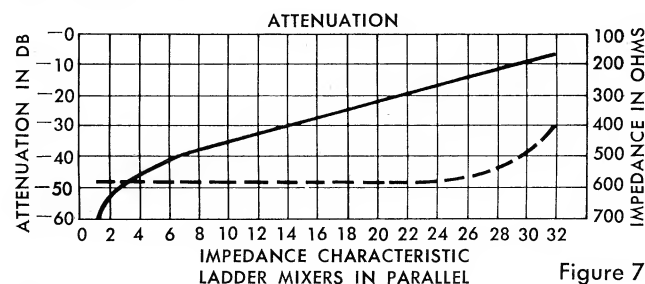


Figure 7

Balanced Circuitry

Balanced circuitry should always be used when entering or leaving the console. For example, in an installation where additional equipment is located some distance from the mixer section, balanced circuitry could be used as a protection against ground loop hum. However, unbalanced circuits are the simplest and most economical circuitry for the internal wiring within a console.

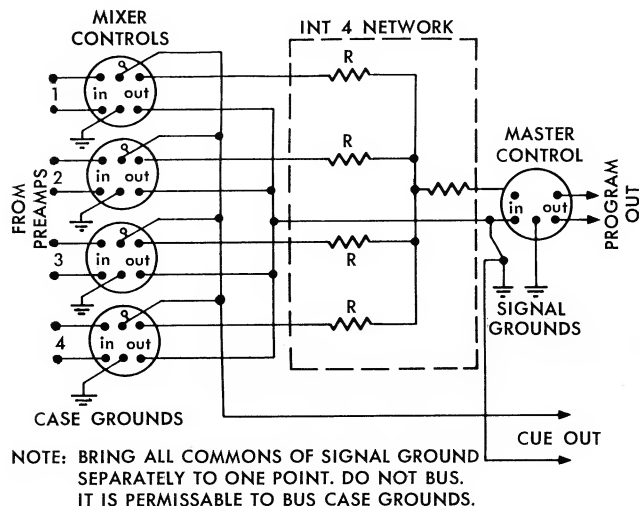


Figure 8

High Level Parallel Ladder Mixer

For highest quality, the best circuit for combining mixer outputs is the high level parallel mixer. Used with a master gain control of the same impedance, it will combine any number of circuits with equal impedances to form a single program channel. The four circuits shown in the illustration would result in a loss of approximately 18 db. The cases should be grounded, but circuit grounds (common) should be taken separately to a single ground point. The circuit shown is monaural and should be duplicated if additional channels are required for stereo application.

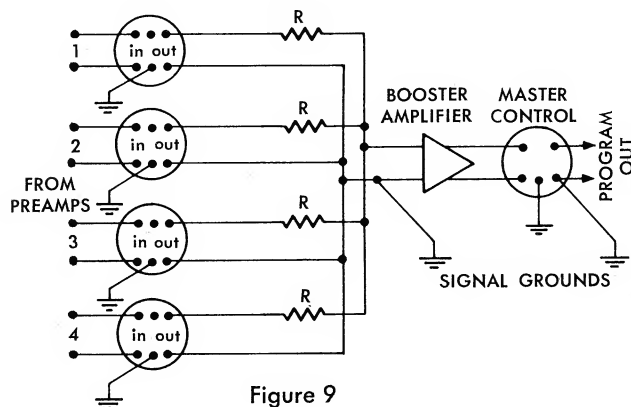


Figure 9

Parallel Ladder Mixer with Minimum Loss Network

The parallel ladder mixer with a minimum loss network is a special application and is used where additional circuits have been added to a system or where losses have been incurred and a gain is required to offset that loss. Such a circuit may be used only where an unloaded input is available at the booster stage. The series output resistor is eliminated and the master gain control must be used after the booster amplifier stage. The circuit may be duplicated for stereo application. The major advantage of the circuit is that it permits a large number of mixers to be combined with 6 db less loss than with a conventional mixer network.

Low Level Mixing

Mixing in low-level circuits before preamplification decreases the number of preamplifiers required because the signals are combined in the mixers and then fed to a single preamplifier. On the other hand, such a system has greater susceptibility to contact noise when amplification follows the mixing process. Low level mixing generally is regarded as a compromise solution, but it may be satisfactory for use in portable installations or in other systems where exceptionally high quality of the final output is not the prime consideration.

SUMMARY

By way of a summary, the various circuits and the recommended applications for each are:

LADDER NETWORKS	have their best application in mixer controls.
"T" and "H"	for precision attenuators and low insertion loss requirements.
"L"	used in measuring devices and in speaker controls.
POTENTIOMETERS	are for high impedance circuits and grid controls.
BALANCED LADDER	rarely is used except where balanced circuitry is necessary for special mixer requirements.
"H"	is the balanced version of the "T".
"U"	is the balanced version of the "L".

ORDERING

Altec has mixers, attenuators, potentiometers and other precision equipment for any and all professional sound and audio needs. These controls are described in the pages which follow, and may be ordered in a variety of types and circuits for monaural or multi-channel applications. Inquiries concerning special problems are invited.

To order from this catalog, simply order by number. The chart associated with each type of equipment lists the single model number at the left, circuitry and related specifications, then model numbers for two-gang (or more) units. Other information will be found at the bottom of each chart, and a dimensional table is reproduced on Page 13.

NOTE: All rotary controls are supplied with knob and dial, but may be ordered without knob and/or dial. Escutcheons and plug-in mounting frames are NOT supplied with straight line controls and must be ordered separately.

There are two sizes of escutcheon plates and three sizes of mounting frames for straight line controls. These accessories should be ordered by part number as follows:

Escutcheons:

For 1-, 2- and 3-gang units, order part number 9611.

For 4-, 5- and 6-gang units, order part number 9622.

Mounting Frames:

For 1- and 2-gang units, order part number 9701.

For 3-gang units, order part number 9702.

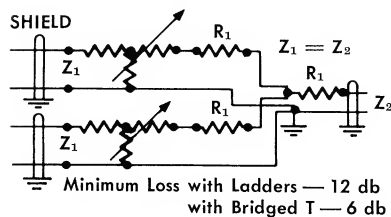
For 4-, 5- and 6-gang units, order part number 9703.

Dimensional drawings of these accessories will be found on page 13.

A series of representative mixer circuits are shown below. Additional reference materials are included in this catalog. On Page 14 are pad circuit drawings and formulae, and a V U scale. A pad loss table is on Page 15, and a voltage ratio table will be found on Page 16.

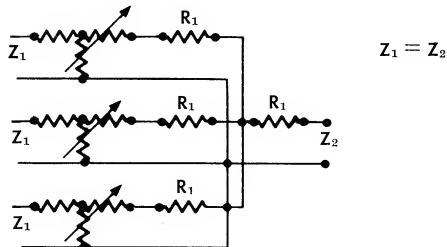
REPRESENTATIVE CIRCUIT MIXERS

TWO-POSITION MIXER



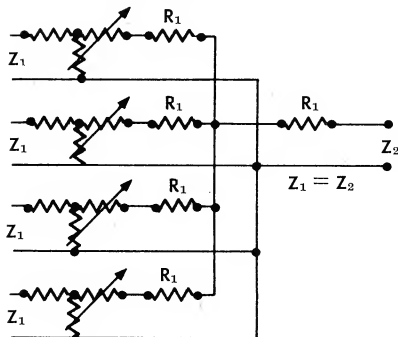
$$\frac{N-1}{N+1} Z = R_1 \quad N = \text{Number of Inputs}$$

THREE-POSITION MIXER



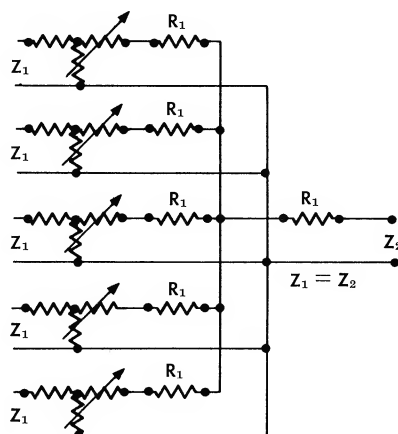
Minimum Loss with Ladders — 15.5 db
with Bridged T — 9.5 db

FOUR-POSITION MIXER



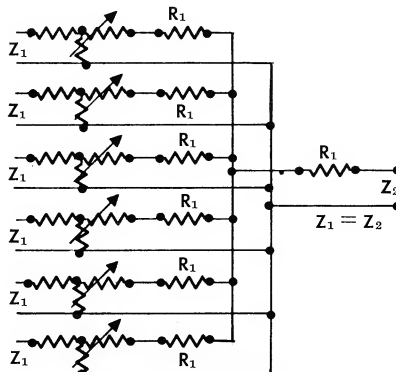
Minimum Loss
with Ladders — 18 db
with Bridged T — 12 db

FIVE-POSITION MIXER



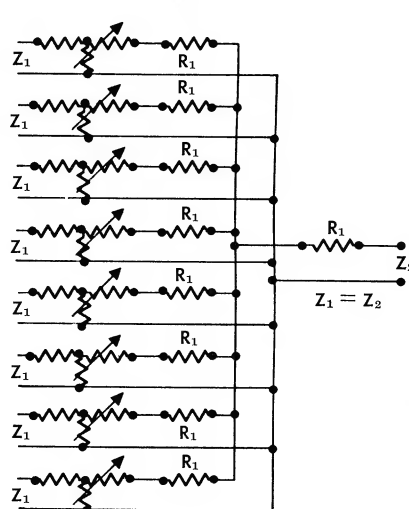
Minimum Loss
with Ladders — 20 db
with Bridged T — 14 db

SIX-POSITION MIXER



Minimum Loss
with Ladders — 21.6 db
with Bridged T — 15.5 db

EIGHT-POSITION MIXER



Minimum Loss
with Ladders — 24.1 db
with Bridged T — 18.1 db

Impedance	2-POSITION	3-POSITION	4-POSITION	5-POSITION	6-POSITION	8-POSITION
30	10	15	18	20	21.42	23.3
50	16.6	25	30	33.3	35.7	38.8
150	50	75	90	100	107	116.8
200	66.6	100	120	133	142.8	155.5
250	83.3	125	150	166	178.5	194.6
500	166	250	300	333	357	388
600	200	300	360	400	428.4	466

R₁ value in ohms for various mixer circuits

Figure 10

ORDERING INFORMATION

ADDENDUM TO THE ATTENUATOR CATALOGUE #AL-1496

Page 4 — "ORDERING" information section on Escutcheons should read as follows:

Escutcheons:

For 1 and 2 gang units order part number 9611

For 3 gang units order part number 9624

For 4, 5, and 6 gang units order part number 9623

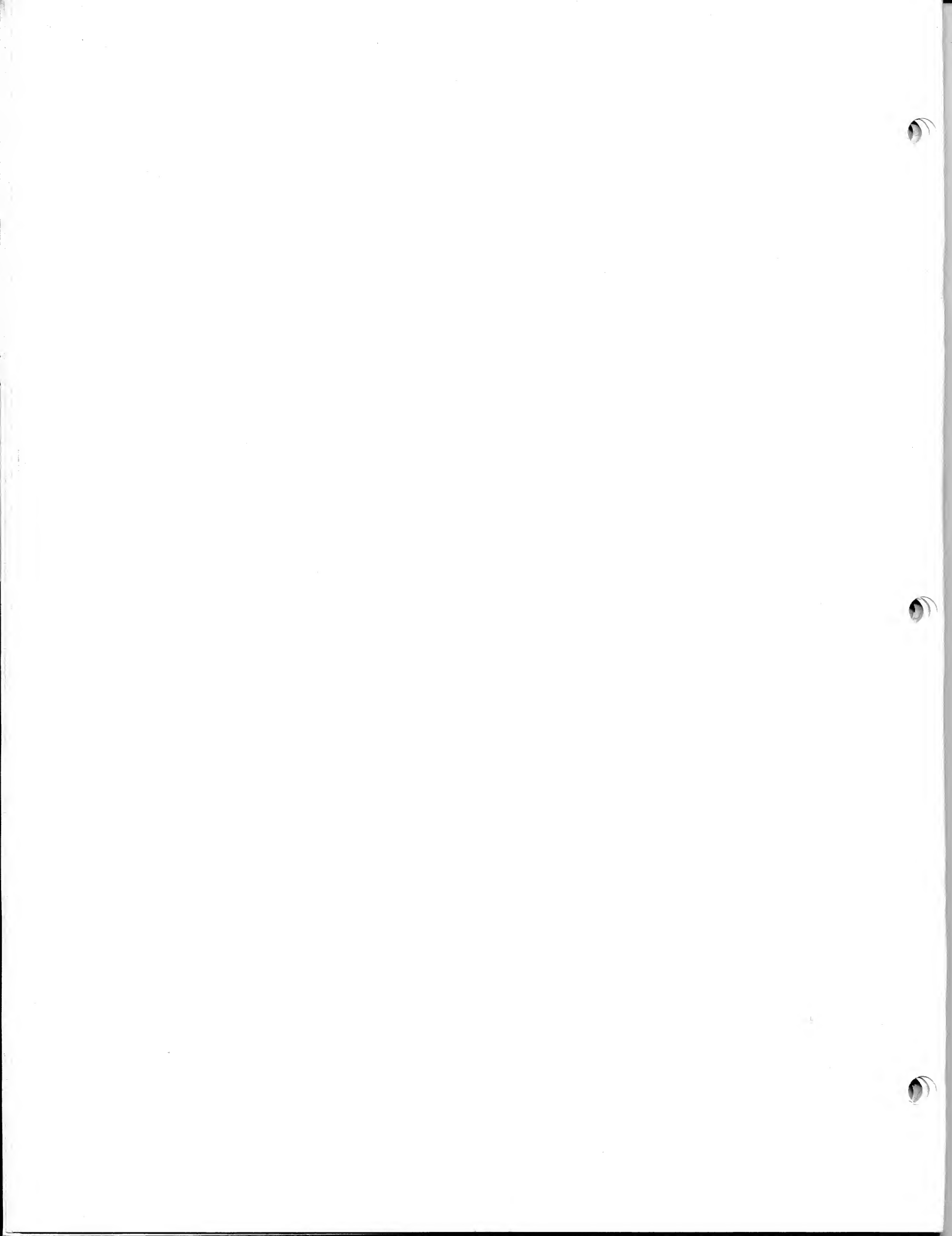
Page 6 — Straight Line Attenuators are 150 and 600 Ω standard impedance.

Page 13 — Chart on "DIMENSION AND WEIGHT INFORMATION" should read as follows:

3 gang - column E (accessories escutcheons) should read
1.750". (not 1.5")

NOTICE !

Any attenuator, of either rotary or straight line configuration, ordered by part number, will be furnished in 600 Ω impedance. If 150 Ω impedance is required, specify on the order. Impedances other than 150 or 600 Ω are available on request with prices upon application.



STRAIGHT LINE MIXERS — 8272 thru 8322

Altec Straight Line Mixers, precision controls for signal blending, are designed for the most critical applications in musical scoring, re-recording, radio and television usage, and high quality sound reinforcement systems. These mixers feature a nylon bearing on a longitudinal-honed, chrome-plated shaft which provides almost friction-free operation. Less than 40 grams of pressure is required to alter a setting, and break-away friction is not apparent. The resistance wire and the dual contact brushes are made of the same material as the wire to prevent generation of thermal voltages. A dirt trap over the resistance element catches dirt and air-borne particles, and greatly decreases the need for periodic cleaning

and maintenance. Connections are made by a plug to the connection cable socket or a plug-in adapter, permitting rapid disassembly for inspection.

An adjustable screw permits alteration of the pressure required to move the control knob, a useful feature for those installations where a sound engineer may prefer more than the 40-gram minimum. For stereo applications, the Altec Straight Line Mixer is available in 2-, 3-, 4-, 5- and 6-gang assemblies, all operating with a single knob to simplify control console design.

Special frames for plug-in mounting and special escutcheons for these mixers are available as accessories and must be ordered separately. All straight line mixers are supplied with a knob.

Specifications for these mixers are listed in the table below.

STRAIGHT LINE MIXERS

6 db insertion loss for all ladders

TYPE NO.	CIRCUIT	NO. OF STEPS	DB PER STEP	2-GANG MODEL	3-GANG MODEL	4-GANG MODEL	5-GANG MODEL	6-GANG MODEL
8272	LADDER	SLIDE WIRE		8282	8292	8302	8309	8316
8273	LADDER	20	2	8283	8293	8303	8310	8317
8274	LADDER	30	1½	8284	8294	8304	8311	8318
8275	BRIDGE-T	20	2	8285	8295	8305	8312	8319
8276	BRIDGE-T	30	1½	8286	8296	8306	8313	8320
8277	BAL-LADDER	SLIDE WIRE		8287	8297	.....	.....	.....
8278	BAL-LADDER	20	2	8288	8298	8307	8314	8321
8279	BAL-LADDER	30	1½	8289	8299	8308	8315	8322
8280	BAL-H	20	2	8290	8300	.....	.....	.....
8281	BAL-H	30	1½	8291	8301	.....	.....	.....

Supplied with knob only. Escutcheons and plug-in mounting frames must be ordered separately. (See Page 4.)

CALIBRATED ATTENUATORS — Unbalanced and Balanced — 8400 thru 8504

Unlike mixers, Altec Calibrated Attenuators are made with detents to facilitate return to exact control settings and are equipped with a calibrated dial. The insertion loss of the "T" and "H" circuit attenuators is zero; and for the ladder circuit attenuators, the insertion loss is only 6 db.

Altec Calibrated Attenuators are available in both unbalanced and balanced circuits. The unbalanced are designed around ladder or bridge-T circuitry, while the balanced attenuators utilize the balanced ladder or balanced-H type of circuit. Models have standard impedance of 150 and 600 ohms, and are available in single, double and triple gang types.

Specifications of these Altec Calibrated Attenuators are listed in the tables below.

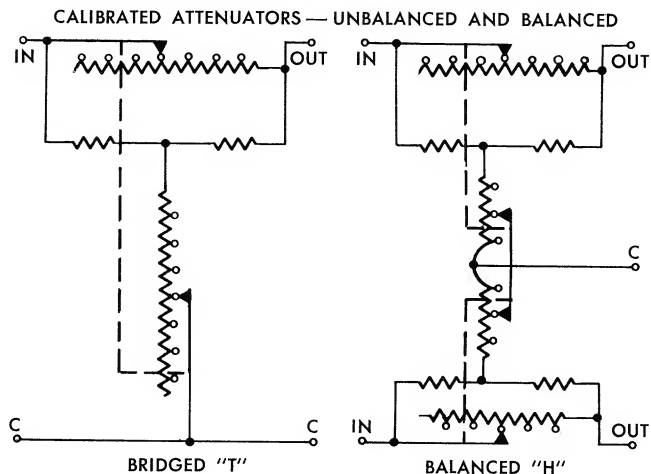
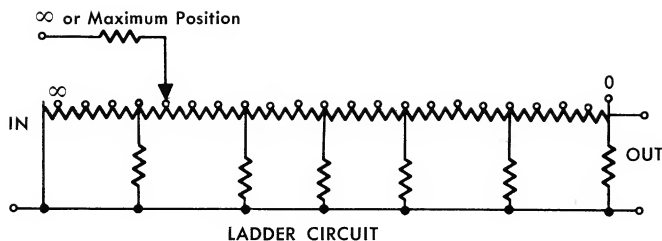
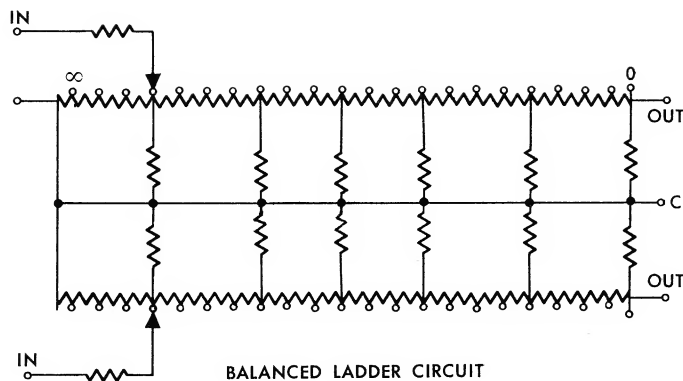


Figure 11



Figures 12



UNBALANCED CALIBRATED ATTENUATORS

Standard Impedances 150 and 600 Ω

Note: Ladders have 6 db insertion loss.

TYPE NO.	CIRCUIT	NO. OF STEPS	DB PER STEP	TOTAL DB LOSS	DETENT DEGREES	TOTAL DEGREES OF ROTATION	SIZE FRAME	2-GANG MODEL	3-GANG MODEL
8400	LADDER	10	1	10	15	150	1½	8419	8438
8401	LADDER	20	1	20	15	300	1½	8420	8439
8402	LADDER	30	1	30	11¼	337½	1½	8421	8440
8403	LADDER	10	2	20	15	150	1½	8422	8441
8404	LADDER	20	2	40	15	200	1½	8423	8442
8405	LADDER	10	5	50	15	150	1½	8424	8443
8406	BRIDGE-T	10	1/10	1	15	150	1½	8425	8444
8407	BRIDGE-T	20	1/10	2	15	300	2¼	8426	8445
8408	BRIDGE-T	10	1/2	5	15	150	1½	8427	8446
8409	BRIDGE-T	20	1/2	10	15	300	2¼	8428	8447
8410	BRIDGE-T	10	1	10	15	150	1½	8429	8448
8411	BRIDGE-T	15	1	15	15	225	1½	8430	8449
8412	BRIDGE-T	20	1	20	15	300	2¼	8431	8450
8413	BRIDGE-T	30	1	30	11¼	337½	2¼	8432	8451
8414	BRIDGE-T	10	2	20	15	150	1½	8433	8452
8415	BRIDGE-T	15	2	30	15	225	1½	8434	8453
8416	BRIDGE-T	20	2	40	15	300	2¼	8435	8454
8417	BRIDGE-T	30	2	60	11¼	337½	2¼	8436	8455
8418	BRIDGE-T	10	5	50	15	150	1½	8437	8456

BALANCED CALIBRATED ATTENUATORS

Standard Impedances: 150 and 600 Ω

Note: Ladders have 6 db insertion loss.

TYPE NO.	CIRCUIT	NO. OF STEPS	DB PER STEP	TOTAL DB LOSS	DETENT DEGREES	TOTAL DEGREES OF ROTATION	SIZE FRAME	2-GANG MODEL	3-GANG MODEL
8457	BAL-LADDER	10	1	10	15	150	1½	8475	8493
8458	BAL-LADDER	20	1	20	15	300	2¼	8476	8494
8459	BAL-LADDER	20	1	30	11¼	337½	2¼	8477	8495
8460	BAL-LADDER	10	2	20	15	150	1½	8478	8496
8461	BAL-LADDER	20	2	40	15	200	2¼	8479	8497
8462	BAL-H	10	1/10	1	15	150	2¼	8480	8498
8463*	BAL-H	20	1/10	2	15	300	2¼	8481**	.....
8464	BAL-H	10	1/2	5	15	150	2¼	8482	8499
8465*	BAL-H	20	1/2	10	15	300	2¼	8483**	.....
8466	BAL-H	10	1	10	15	150	2¼	8484	8500
8467	BAL-H	15	1	15	15	225	2¼	8485	8501
8468*	BAL-H	20	1	20	15	300	2¼	8486**	.....
8469*	BAL-H	30	1	30	11¼	337½	2¼	8487**	.....
8470	BAL-H	10	2	20	15	150	2¼	8488	8502
8471	BAL-H	15	2	30	15	225	2¼	8489	8503
8472*	BAL-H	20	2	40	15	300	2¼	8490**	.....
8473*	BAL-H	30	2	60	11¼	337½	2¼	8491**	.....
8474	BAL-H	10	5	50	15	150	2¼	8492	8504

*in 2-gang frame **in 4-gang frame Supplied with knob and dial

Unbalanced and Balanced CALIBRATED GRID CONTROL POTENTIOMETERS — 8600 thru 8645

Altec Calibrated Grid Control Potentiometers are designed to insure calibration into an open circuit such as the grid of a Class "A" amplifier tube. For any specific application, the potentiometer selected should be the one that provides the least possible amount of resistance. For example, a high gain triode may have low grid input impedance for the higher frequencies which would require a low value of potentiometer resistance of about 50,000 ohms. The capacity of the input circuit to ground controls the high frequency attenuation, therefore, the lower the value of the potentiometer, the smaller will be the effect. In good transmission design, the leads should be kept as short as possible. A line-to-grid transformer is recommended when a potentiometer is used on the amplifier side of the coil.

Altec Grid Control Potentiometers are available with unbalanced circuits for single grids, and with balanced circuits for push-pull grids. They may be ordered without taper and with no infinity position. Although all units are detented, undetented models are available on special order.

Specifications for these units are listed in the tables below.

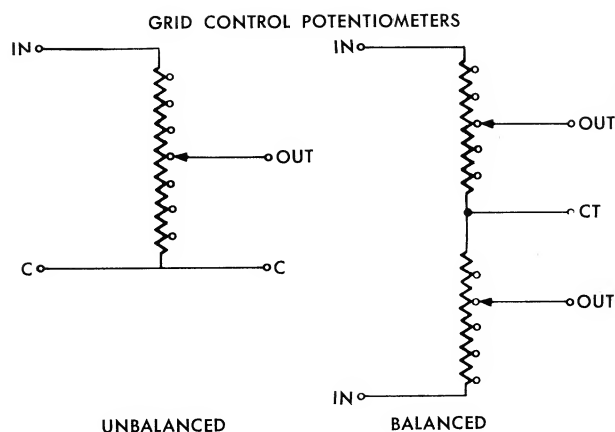


Figure 13

UNBALANCED CALIBRATED GRID CONTROL POTENTIOMETERS

TYPE NO.	STEPS	DB PER STEP	TOTAL DB LOSS	DETENT DEGREES	TOTAL DEGREES OF ROTATION	SIZE FRAME	2-GANG MODEL	3-GANG MODEL
8600	10	5	50	15	150	1½	8607	8614
8601	15	5	75	15	225	1½	8608	8615
8602	20	3	60	15	300	1½	8609	8616
8603	30	1	30	11¼	337½	1½	8610	8617
8604	30	2	60	11¼	337½	1½	8611	8618
8605	40	1	40	7½	300	2¼	8612	8619
8606	40	2	80	7½	300	2¼	8613	8620
8640	20	2	40	15	300	1½	8641	8642

BALANCED CALIBRATED GRID CONTROL POTENTIOMETERS

8621	10	5	50	15	150	1½	8628	8635
8622	15	5	75	15	225	1½	8629	8636
8623	20	3	60	15	300	2¼	8630	8637
8624	30	1	30	11¼	337½	2¼	8631	8638
8625	30	2	60	11¼	337½	2¼	8632	8639
8626*	40	1	40	7½	300	2¼	8633**	.....
8627*	40	2	80	7½	300	2¼	8634**	.....
8643	20	2	40	15	300	1½	8644	8645

*in 2-gang frame

**in 4-gang frame

STANDARD IMPEDANCES

1000 Ω	50,000 Ω
5000 Ω	100,000 Ω
10,000 Ω	250,000 Ω
25,000 Ω	500,000 Ω

Supplied with knob and dial

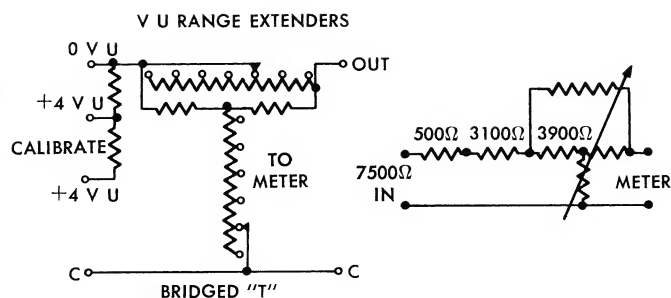


Figure 14

V U RANGE EXTENDERS — 8700 thru 8734

Altec VU Range Extenders are rotary controls conforming to the "T" circuit design which are designed to extend the range of standard VU meters. Each unit consists of a 3900-ohm bridged-T attenuator with building-out resistors at the input. With the 3600-ohm series resistors in the circuit, the input impedance is 7500 ohms, and the output impedance is 3900 ohms. Two fixed resistors (3100 and 500 ohms) permit the range to start at +4 VU. The terminals of these resistors appear at the back of the unit to permit use of wire-wound adjusting potentiometers for stereo balance or calibration simply by selecting the appropriate solder terminal. Altec VU Range Extenders are available in single, 2- and 3-gang models. Specifications for these units are listed in the table below.

V U RANGE EXTENDERS

TYPE NO.	NO. OF STEPS	DB PER STEP	RANGE CLOCKWISE	DETENT DEGREES	TOTAL DEGREES OF ROTATION	SIZE FRAME	2-GANG MODEL	3-GANG MODEL
8700	10	1	+4 TO +14	15	150	1½	8713	8724
8701	10	2	+4 TO +24	15	150	1½	8714	8725
8702	12	1	1 MW +4 TO +14 & OFF	11¼	135	1½	8715	8726
8703	12	2	1 MW +4 TO +24 & OFF	11¼	135	1½	8716	8727
8704	16	1	+4 TO +20	15	240	2¼	8717	8728
8705	15	2	+4 TO +34	15	225	2¼	8718	8729
8706	20	1	+4 TO +24	15	300	2¼	8719	8730
8707	20	2	+4 TO +44	15	300	2¼	8720	8731
8708	19	1	1 MW +4 TO +20 & OFF	15	285	2¼	8721	8732
8709	20	2	1 MW +4 TO +40 & OFF	15	300	2¼	8722	8733
8710	30	1	+4 TO +34	11¼	337½	2¼	8723	8734
8711*	40	1	+4 TO +44	7½	300	2¼	.....	.....
8712*	42	1	1 MW +4 TO +44 & OFF	7½	315	2¼	.....	.....

*in 2-gang frame
Supplied with knob and dial

PRECISION MEASURING EQUIPMENT

Precision Decade Attenuators — 8735 thru 8746

Precision Impedance Matching Networks — 8748 thru 8754

Precision Decade Resistors — 8755 thru 8768

The Altec series of Precision Measuring Equipment, primarily intended for use in gain sets and for measurements of transmission levels, consists of Altec Precision Decade Attenuators, Altec Precision Impedance Matching Networks, and Altec Precision Decade Resistors.

The Altec Precision Decade Attenuator is designed as a 10-step unit within 150 degrees of rotation, and with a 15-degree detent angle. Attenuators are available in either the "T" or "H" types of circuitry, and with 150 or 600 ohms impedance. To insure best results and continuing accuracy over an indefinite period, steady sine wave power input levels should be limited to 1 watt or less, although program material of 5 watts can be handled for an unlimited time. These units are available with 0.1, 1 or 10 db steps. Additional specifications will be found in the table on Page 11.

Altec Precision Impedance Matching Networks consist of a series

of fixed matching pads selectable by a rotary switch. These networks are ideal for gain sets since they are designed to permit high precision in matching impedances and are calibrated for relative losses due to matching of unequal impedance ratios. The networks are available in both the "T" and "H" circuit types, and with 150 or 600 ohm input impedances with a series of varied output impedances.

These Altec networks are reversible and, therefore, may be matched to either input or output impedances.

The "H" circuit networks may be balanced to common center or to ground.

Quality workmanship permits construction of networks with extremely low leakage.

Specifications for these units will be found in the table on Page 10.

Altec Precision Decade Resistors are available in 9 or 10 step models with resistance steps from 0.1 ohm to 100,000 ohms per step for decade box use or bridges. Made with precision wire-wound resistors, all units have an accuracy of 1/20th of one percent. All fine (pure) silver contacts and dual fine (pure) silver brushes permit less than two milliohm contact resistance in the entire switch assembly.

Additional specifications will be found in the table on Page 11.

PRECISION DECADE ATTENUATORS

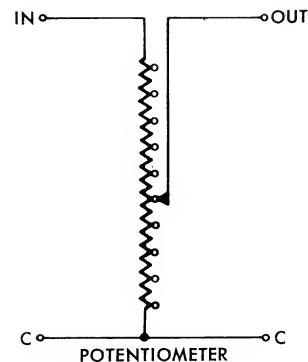
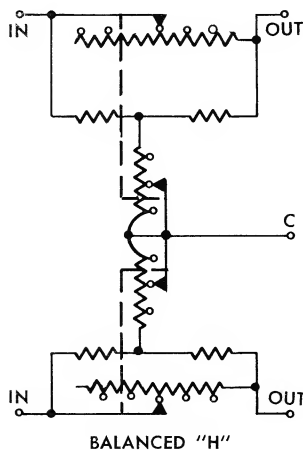
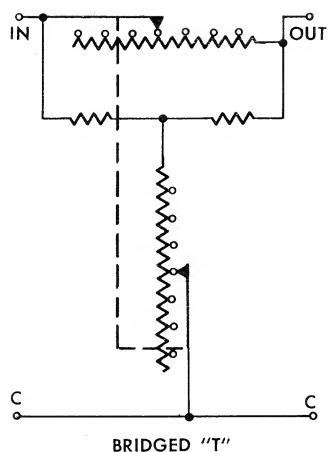


Figure 15

PRECISION IMPEDANCE MATCHING NETWORKS

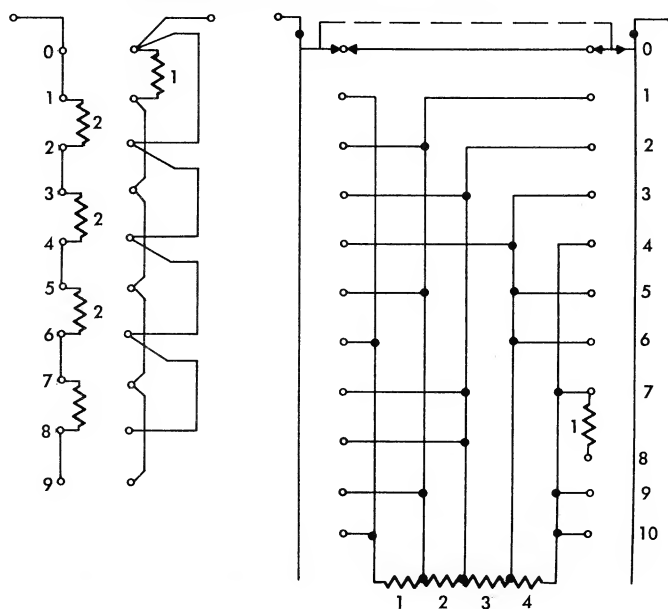
Detent Degrees: 20°

Total Rotation: 140°

TYPE NO.	CIRCUIT	INPUT Z	INSERTION LOSS IN DB FOR OUTPUT IMPEDANCE								SIZE FRAME
			30 Ω	50 Ω	125 Ω	150 Ω	200 Ω	250 Ω	500 Ω	600 Ω	
8747	T	150 Ω	20	20	20	20	10	10	10	0	1½
8748	T	150 Ω	20	20	20	20	20	20	20	20	1½
8749	T	600 Ω	20	20	20	20	10	10	10	0	1½
8750	T	600 Ω	20	20	20	20	20	20	20	20	1½
8751	H	150 Ω	20	20	20	20	10	10	10	0	2¼
8752	H	150 Ω	20	20	20	20	20	20	20	20	2¼
8753	H	600 Ω	20	20	20	20	10	10	10	0	2¼
8754	H	600 Ω	20	20	20	20	20	20	20	20	2¼

Supplied with knob and dial.

PRECISION DECADE RESISTORS



9 step decade — 360° Rotation
36° between steps

10 step decade — 150° Rotation
15° between steps

Figure 17

PRECISION DECADE ATTENUATORS

TYPE NO.	CIRCUIT	IMPEDANCE	STEPS	DB PER STEP	TOTAL DB LOSS	DETENT DEGREES	TOTAL DEGREES OF ROTATION	SIZE FRAME
8735	T	150 Ω	10	1/10	1	15	150	1½
8736	T	600 Ω	10	1/10	1	15	150	1½
8737	T	150 Ω	10	1	10	15	150	1½
8738	T	600 Ω	10	1	10	15	150	1½
8739	T	150 Ω	10	10	100	15	150	1½
8740	T	600 Ω	10	10	100	15	150	1½
8741	H	150 Ω	10	1/10	1	15	150	2¼
8742	H	600 Ω	10	1/10	1	15	150	2¼
8743	H	150 Ω	10	1	10	15	150	2¼
8744	H	600 Ω	10	1	10	15	150	2¼
8745	H	150 Ω	10	10	100	15	150	2¼
8746	H	600 Ω	10	10	100	15	150	2¼

Supplied with knob and dial.

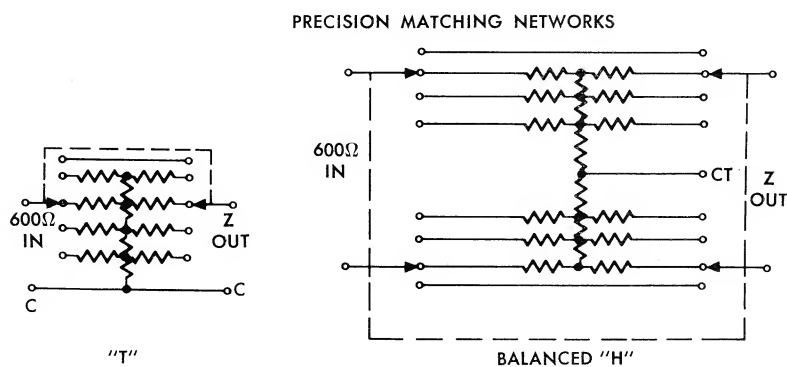


Figure 16

PRECISION DECADE RESISTORS Decade Box Type 1/10% accuracy

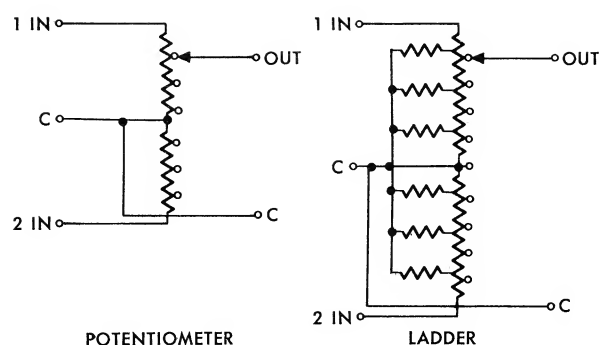
TYPE NO.	STEPS IN OHMS	OHMS RANGE	TYPE NO.	STEPS IN OHMS	OHMS RANGE
8755	.1	0 TO .9	8762	.1	0 TO 1
8756	1	0 TO 9	8763	1	0 TO 10
8757	10	0 TO 99	8764	10	0 TO 100
8758	100	0 TO 999	8765	100	0 TO 1000
8759	1000	0 TO 9999	8766	1000	0 TO 10000
8760	10000	0 TO 99999	8767	10000	0 TO 100000
8761	100000	0 TO 999999	8768	100000	0 TO 1000000
9 steps — 0 to 9 Total Rotation: 360° 18° per step			10 steps — 0 thru 10 Total Rotation: 150° 15° per step		

Supplied with knob and dial.

MOTION PICTURE PROJECTION AND TURNTABLE FADERS — 8800 thru 8805

In the projection of motion pictures, the changeover from one reel of film to the next should be imperceptable... not only visually, but audibly as well. Altec Motion Picture Projection and Turntable Faders are designed to accomplish this function. And they are equally applicable for use in radio broadcasting to switch over from one turntable to another.

The Altec Fader is available in ladder and potentiometer circuitry, and with either 16 or 22 steps on each side of infinity. Calibrated dials are marked in red on the left side of infinity, and in white on the right for ease of operation. Detents are at 10 degrees on the 16-step model, and at $7\frac{1}{2}$ degrees on the 22-step unit. Impedances up to 600 ohms are available, as well as values up to 500,000 ohms for the potentiometer models. Two gang units for stereo application are available on special order. Specifications for these units are listed in the table below.



MOTION PICTURE PROJECTION AND TURNTABLE FADERS

Figure 18

MOTION PICTURE PROJECTION AND TURNTABLE FADERS also available in stereo types

TYPE NO.	CIRCUIT	NO. OF STEPS ON EACH SIDE OF INFINITY	TOTAL NO. OF STEPS	DB PER STEP	RANGE	DETENT DEGREES	TOTAL DEGREES OF ROTATION	SIZE FRAME
8800	LADDER	16	32	3	0 — 45 — ∞ — 45 — 0	10	320	1½
8801	LADDER	22	45	2	0 — 42 — ∞ — 42 — 0	7½	337½	2¼
8804	POTENTIOMETER	16	32	3	0 — 45 — ∞ — 45 — 0	10	320	1½
8805	POTENTIOMETER	22	45	2	0 — 42 — ∞ — 42 — 0	7½	337½	2¼

Supplied with knob and dial.

STEREO PAN POTENTIOMETERS — 8806, 8807, 8808, 8809

The advent of stereo and multi-channel transmission created problems in transferring the apparent position of a sound source from one section of the recording field to another. The arrival time of a sound will influence the apparent position of its source, and the intensity of that sound can offset the effects of its arrival time. A change of only 3 db in intensity is enough to displace the apparent source across the recorded field, an effect that may be controlled by the use of Altec Stereo Pan Potentiometers.

Either a two-channel or a three-channel pan pot may be used to pick up a monaural sound and transfer it to any 'geometric' position desired in the final stereo transmission. Stereo pan potentiometers differ from the usual mixer in that — for a two-channel system — two oppositely wound controls are ganged in

such a way that the 3 db down point of each control occurs at zero degrees. (For a three-channel system, three controls are ganged so that the 3 db down point occurs at 45 degrees to either side of the center.) At either 90-degree position, the extreme opposite channel is at infinite attenuation.

The unusual taper of each winding demands 16 positions in each unit in order to attain the smoothest transition throughout the audible range of control. Attenuation to extremes is rapid at both ends, but slow in the region of overlap from one section to another. This attenuation rate is precise, conforming to the exacting calculations which govern angular displacement in the sound field as indicated by changes in level.

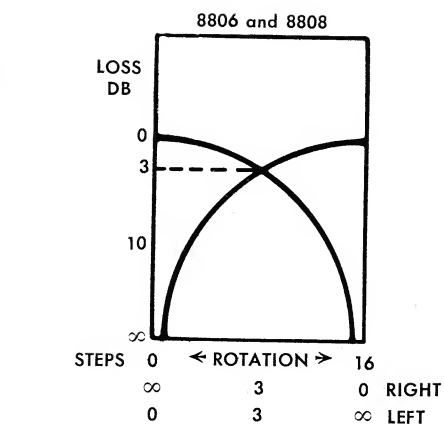
Special frames for plug-in mounting and special escutcheons for straight line stereo pan potentiometers are available as accessories. Dials and knobs are supplied with rotary models.

Specifications will be found in the table below.

STEREO PAN POTENTIOMETERS

MODEL NO.	TYPE	IMPEDANCE	INSERTION LOSS	TOTAL DEGREES OF ROTATION	NO. OF STEPS	ATTENUATION
8806	Straight Line — 1 channel into 2	600 Ω	12 db	.....	16	(Right) ∞ — —3 db — 0 (Left) 0 — —3 db — ∞
8807	Straight Line — 1 channel into 3	600 Ω	12 db	.....	22	(Right) 0 — —3 db — ∞ — —3 db — 0 (Center) ∞ — —3 db — 0 — —3 db — ∞ (Left) 0 — —3 db — ∞ — —3 db — 0
8808	Rotary — 1 channel into 2	600 Ω	12 db	270°	16	(Right) ∞ — —3 db — 0 (Left) 0 — —3 db — ∞
8809	Rotary — 1 channel into 3	600 Ω	12 db	270°	22	(Right) 0 — —3 db — ∞ — —3 db — 0 (Center) ∞ — —3 db — 0 — —3 db — ∞ (Left) 0 — —3 db — ∞ — —3 db — 0

Rotary Pan Potentiometers are supplied with knob and dial. Straight line Pan Potentiometers are supplied with the knob only. Escutcheon and plug-in mounting frames for straight line models must be ordered separately. (See Page 4.)



STEREO PAN POTENTIOMETERS

8807 and 8809

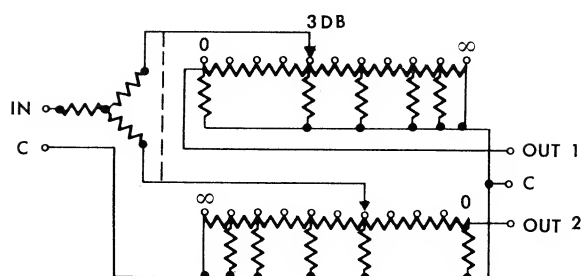
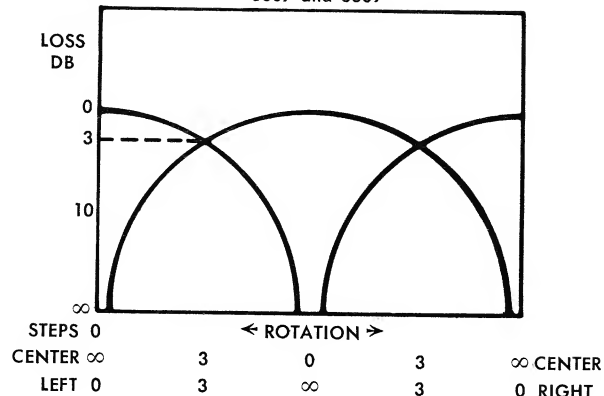
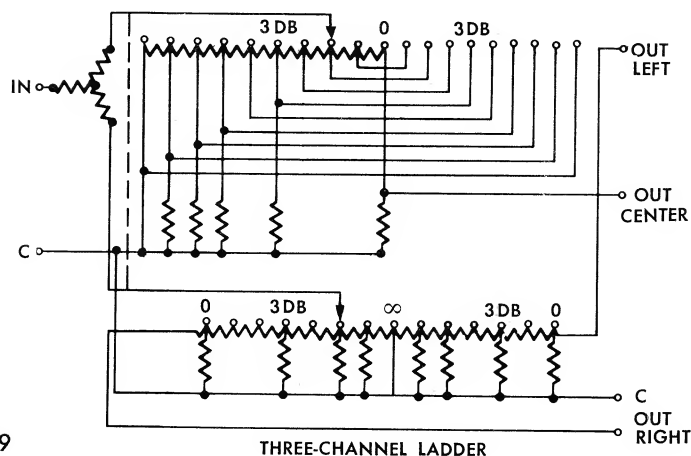


Figure 19



DIMENSION AND WEIGHT INFORMATION

ROTARY CONTROLS					STRAIGHT LINE CONTROLS		ACCESSORIES	
Rotary Mixers, Calibrated Attenuators, Calibrated Grid Control Potentiometers, V U Range Extenders, Precision Measuring Equipment, Motion Picture Faders.					Straight Line Mixers, Stereo Pan Pots		Escutcheons Mounting Frames	
Frame Size	A & B	C	Weight (oz.)		D	Weight (oz.)	E	F
			1½"	2¼"				
Single	1½" or 2¼"	2.30"	7	11	1⅞"	20.3	1.5"	1.25"
2-Gang	1½" or 2¼"	3.47"	10	14	1⅞"	22.5	1.5"	1.25"
3-Gang	1½" or 2¼"	4.59"	13	17	1½"	28.5	1.5"	1.625"
4-Gang	1½" or 2¼"	5.78"	16	20	2¾"	36.8	3"	2.875"
5-Gang	1½" or 2¼"	6.87"	19	23	2¾"	38.9	3"	2.875"
6-Gang	1½" or 2¼"	8.02"	22	26	2¾"	41.0	3"	2.875"

NOTE: All rotary units may be opened by removing the mounting plate at the knob end of the control and then sliding the case off the unit.

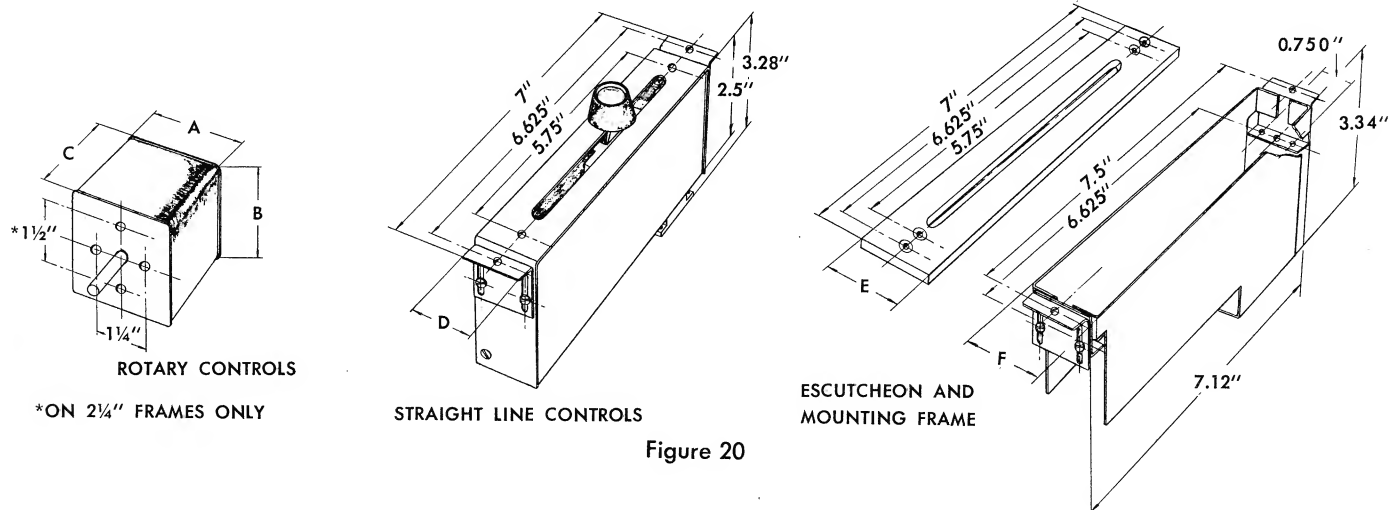
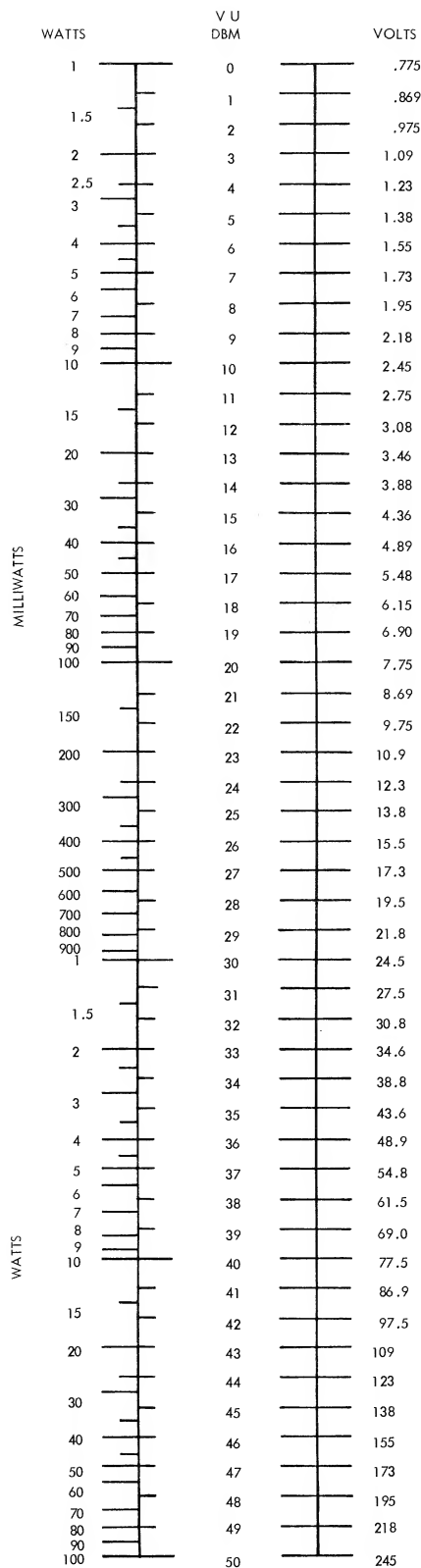


Figure 20

V U SCALE



VOLTS MEASURED ON 600 Ω LINE
THE FORMULA FOR USE WITH OTHER IMPEDANCES Z:

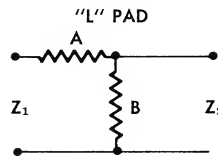
$$E = V \sqrt{\frac{Z}{600}}$$

FOR EXAMPLE - 150 Ω at -4 V U

$$E = 1.23 \sqrt{\frac{150}{600}} = .615 \text{ VOLTS}$$

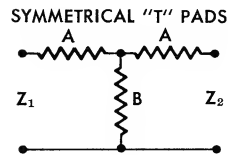
PAD CIRCUIT AND FORMULAE

(K = Voltage ratio — See Table, Page 16)



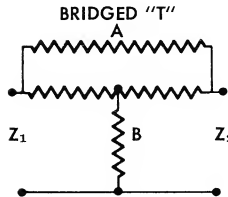
$$\frac{K-1}{K} Z = A$$

$$\frac{1}{K-1} Z = B$$



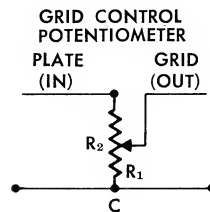
$$\frac{K-1}{K+1} Z = A$$

$$\frac{K}{K^2-1} Z = B$$



$$(K-1) Z = A$$

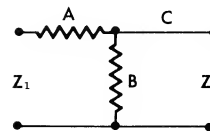
$$\frac{1}{K-1} Z = B$$



$$\frac{1}{K} Z = R_1$$

$$Z - R_1 = R_2$$

MATCHING PADS
MINIMUM LOSS



$$A = \sqrt{Z_1 Z_2}$$

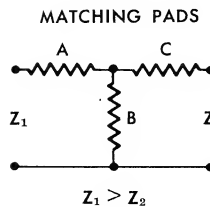
$$B = \frac{Z_1 Z_2}{A}$$

$$C = 0$$

$$Z_1 > Z_2$$

$$\text{DB LOSS} = 20 \log_{10} (R + \sqrt{R^2 - 1})$$

$$\text{WHERE } R^2 = \frac{Z_1}{Z_2}$$



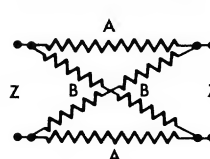
$$A = Z_1 \left[\frac{K^2 + 1}{K^2 - 1} - \left(\frac{2}{r} \frac{K}{K^2 - 1} \right) \right]$$

$$B = 2 \frac{Z_1}{r} \left(\frac{K}{K^2 - 1} \right)$$

$$C = Z_2 \left[\frac{K^2 + 1}{K^2 - 1} - \left(2r \frac{K}{K^2 - 1} \right) \right]$$

$$r = \sqrt{\frac{Z_1}{Z_2}}$$

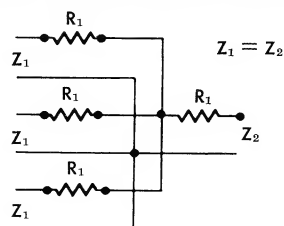
LATTICE NETWORK



$$\left(\frac{K-1}{K+1} \right) Z = A$$

$$\left(\frac{K+1}{K-1} \right) Z = B$$

PARALLEL MIXER OR BRANCHING NETWORK



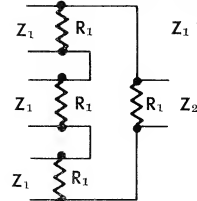
$$\frac{N-1}{N+1} Z = R_1$$

N = Number of inputs

Example: Three-position Mixer Circuit

$$\frac{3-1}{3+1} = \frac{2}{4} \times 600\Omega = 300\Omega = R_1$$

SERIES MIXER OR BRANCHING NETWORK



$$\frac{N+1}{N-1} Z = R_1$$

N = Number of Inputs

PAD LOSS TABLE

Mismatch db	Ratio	Min. Loss db	Mismatch db	Ratio	Min. Loss db	Mismatch db	Ratio	Min. Loss db	Mismatch db	Ratio	Min. Loss db	Mismatch db	Ratio	Min. Loss db
0.	1.0	0.	2.550	5.0	12.53	4.440	9.0	15.30	6.790	17.0	18.18	9.890	37.0	21.67
.00986	.1	2.705	2.607	.1	12.63	4.480	.1	15.36	6.890	.5	18.32	9.940	.5	21.73
.03604	.2	3.770	2.667	.2	12.72	4.510	.2	15.40	7.010	18.0	14.43	10.00	38.0	21.77
.0778	.3	4.548	2.725	.3	12.83	4.550	.3	15.44	7.110	.5	18.57	10.05	.5	21.83
.1223	.4	5.180	2.778	.4	12.91	4.600	.4	15.50	7.220	19.0	18.68	10.10	39.0	21.90
.172	.5	5.723	2.837	.5	13.00	4.640	.5	15.54	7.340	.5	18.80	10.17	.5	21.93
.240	.6	6.190	2.893	.6	13.08	4.660	.6	15.60	7.425	20.0	18.92	10.21	40.0	21.97
.308	.7	6.615	2.932	.7	13.17	4.700	.7	15.67	7.510	.5	19.02	10.28	.5	22.07
.366	.8	6.990	2.997	.8	13.26	4.740	.8	15.70	7.600	21.0	19.13	10.31	41.0	22.11
.440	.9	7.340	3.050	.9	13.33	4.780	.9	15.74	7.700	.5	19.22	10.37	.5	22.15
.510	2.0	7.665	3.090	6.0	13.41	4.800	10.0	15.79	7.795	22.0	19.33	10.42	42.0	22.20
.570	.1	7.955	3.155	.1	13.48	4.880	.2	15.87	7.895	.5	19.42	10.47	.5	22.26
.660	.2	8.235	3.208	.2	13.57	4.950	.4	15.95	7.980	23.0	19.52	10.51	43.0	22.32
.732	.3	8.490	3.240	.3	13.65	5.010	.6	16.05	8.055	.5	19.62	10.57	.5	22.38
.804	.4	8.740	3.293	.4	13.71	5.090	.8	16.13	8.140	24.0	19.73	10.60	44.0	22.40
.883	.5	8.970	3.341	.5	13.79	5.150	11.0	16.22	8.213	.5	19.83	10.66	.5	22.47
.962	.6	9.185	3.400	.6	13.87	5.220	.2	16.32	8.300	25.0	19.91	10.69	45.0	22.51
1.030	.7	9.388	3.453	.7	13.92	5.290	.4	16.38	8.380	.5	20.00	10.77	.5	22.54
1.088	.8	9.580	3.490	.8	14.00	5.340	.6	16.47	8.460	26.0	20.10	10.81	46.0	22.60
1.168	.9	9.775	3.540	.9	14.07	5.410	.8	16.53	8.540	.5	20.17	10.83	.5	22.67
1.244	3.0	9.950	3.600	7.0	13.13	5.470	12.0	16.63	8.630	27.0	20.24	10.88	47.0	22.70
1.312	.1	10.01	3.630	.1	14.20	5.545	.2	16.70	8.680	.5	20.30	10.93	.5	22.73
1.387	.2	10.30	3.683	.2	14.27	5.600	.4	16.77	8.760	28.0	20.40	10.97	48.0	22.77
1.468	.3	10.47	3.735	.3	14.32	5.650	.6	16.84	8.845	.5	20.49	11.02	.5	22.83
1.527	.4	10.62	3.778	.4	14.40	5.700	.8	16.92	8.920	29.0	20.55	11.06	49.0	22.90
1.598	.5	10.76	3.810	.5	14.46	5.750	13.0	16.97	8.970	.5	20.63	11.10	.5	22.93
1.670	.6	10.90	3.853	.6	14.51	5.820	.2	17.03	9.040	30.0	20.70	11.14	50.0	22.96
1.733	.7	11.04	3.908	.7	14.58	5.875	.4	17.12	9.095	.5	20.78	11.55	55.0	23.38
1.807	.8	11.18	3.948	.8	14.65	5.930	.6	17.18	9.160	31.0	20.87	11.83	60.0	23.55
1.868	.9	11.31	3.985	.9	14.70	5.990	.8	17.25	9.250	.5	20.94	12.23	65.0	24.11
1.938	4.0	11.43	4.025	8.0	14.77	6.050	14.0	17.32	9.320	32.0	21.00	12.55	70.0	24.44
2.000	.1	11.56	4.085	.1	14.83	6.093	.2	17.38	9.360	.5	21.07	12.84	75.0	24.74
2.070	.2	11.68	4.105	.2	14.88	6.150	.4	17.43	9.440	33.0	21.13	12.97	80.0	25.02
2.130	.3	11.80	4.160	.3	14.92	6.205	.6	17.50	9.480	.5	21.21	13.37	85.0	25.32
2.200	.4	11.88	4.200	.4	14.97	6.295	.8	17.57	9.560	34.0	21.28	13.62	90.0	25.53
2.266	.5	12.02	4.255	.5	15.05	6.300	15.0	17.63	9.600	.5	21.34	13.81	95.0	25.77
2.318	.6	12.13	4.285	.6	15.10	6.420	.5	17.78	9.660	35.0	21.40	14.07	100.0	25.89
2.391	.7	12.23	4.320	.7	15.15	6.550	16.0	17.92	9.710	.5	21.46			
2.431	.8	12.33	4.360	.8	15.20	6.666	.5	18.05	9.770	36.0	21.51			
2.490	.9	12.43	4.400	.9	15.25				9.840	.5	21.57			

How To Use The Pad Loss Table: Where the impedance ratio is known, the Pad Loss Chart provides the mismatch loss and the minimum loss of the impedance matching network. The center column of each section is the impedance ratio. Mismatch loss is listed to the left, and minimum loss to the right. For example, a 600-ohm line loaded with a 1800-ohm resistor provides a ratio of 3.0. To the left of the 3.0 ratio is the mismatch loss (1.244) and the minimum loss figure, to the right, is 9.960.

All loss figures are in decibels.

VOLTAGE RATIO TABLE

In the Voltage Table, decibels are converted to voltage loss, to the left of the decibel figure; and voltage gain, to the right. For example, to ascertain the gain at 13.5 db, read the figure on the right of the 13.5 listing. The gain would be 4.732 db.

The table repeats every 20 decibels. For readings between 20 and 40 db, subtract 20 db from the total, and move the decimal point one digit to the right for voltage gain; or one decimal to the left for voltage loss. For example, to ascertain the gain at 33.5 db, subtract 20 db from that figure (33.5 db) to obtain the 13.5 ratio and a reading of 4.732 db. Move the decimal point one digit to the right to ascertain the correct reading of 47.32 db for 33.5 db.

NOTE: Only voltage readings taken across identical impedances provide usable ratios.

Voltage Loss	Decibels	Voltage Gain	Voltage Loss	Decibels	Voltage Gain	Voltage Loss	Decibels	Voltage Gain	Voltage Loss	Decibels	Voltage Gain
$\frac{1}{K}$		K	$\frac{1}{K}$		K	$\frac{1}{K}$		K	$\frac{1}{K}$		K
1.0000	.0	1.000	.5623	5.0	1.778	.3162	10.0	3.162	.1178	15.0	5.623
.9886	.1	1.012	.5559	.1	1.799	.3128	.1	3.199	.1758	.1	5.689
.9772	.2	1.023	.5495	.2	1.820	.3090	.2	3.236	.1738	.2	5.754
.9661	.3	1.035	.5433	.3	1.841	.3055	.3	3.273	.1718	.3	5.821
.9550	.4	1.047	.5370	.4	1.862	.3020	.4	3.311	.1698	.4	5.888
.9441	.5	1.059	.5309	.5	1.884	.2985	.5	3.350	.1679	.5	5.957
.9333	.6	1.072	.5248	.6	1.905	.2951	.6	3.388	.1660	.6	6.026
.9226	.7	1.084	.5188	.7	1.928	.2917	.7	3.428	.1641	.7	6.095
.9120	.8	1.096	.5129	.8	1.950	.2884	.8	3.467	.1622	.8	6.166
.9061	.9	1.109	.5070	.9	1.972	.2851	.9	3.508	.1600	.9	6.237
.8913	1.0	1.122	.5012	6.0	1.905	.2818	11.0	3.548	.1585	16.0	6.210
.8810	.1	1.135	.4955	.1	2.018	.2786	.1	3.589	.1567	.1	6.383
.8710	.2	1.148	.4898	.2	2.042	.2754	.2	3.631	.1549	.2	6.457
.8610	.3	1.161	.4842	.3	2.065	.2723	.3	3.673	.1531	.3	6.531
.8511	.4	1.175	.4786	.4	2.080	.2692	.4	3.715	.1514	.4	6.007
.8414	.5	1.189	.4732	.5	2.113	.2661	.5	3.758	.1496	.5	6.683
.8318	.6	1.202	.4677	.6	2.138	.2630	.6	3.802	.1479	.6	6.761
.8222	.7	1.216	.4624	.7	2.163	.2600	.7	3.846	.1462	.7	6.839
.8128	.8	1.230	.4571	.8	2.188	.2570	.8	3.890	.1445	.8	6.918
.8035	.9	1.245	.4519	.9	2.213	.2541	.9	3.936	.1429	.9	6.998
.7943	2.0	1.259	.4467	7.0	2.239	.2512	12.0	3.981	.1413	17.0	7.079
.7852	.1	1.274	.4416	.1	2.265	.2483	.1	4.027	.1396	.1	7.161
.7762	.2	1.288	.4365	.2	2.291	.2455	.2	4.074	.1380	.2	7.244
.7674	.3	1.303	.4315	.3	2.317	.2427	.3	4.121	.1365	.3	7.328
.7586	.4	1.318	.4266	.4	2.344	.2399	.4	4.169	.1349	.4	7.413
.7499	.5	1.334	.4217	.5	2.371	.2371	.5	4.217	.1334	.5	7.499
.7413	.6	1.349	.4169	.6	2.399	.2344	.6	4.266	.1318	.6	7.586
.7328	.7	1.365	.4121	.7	2.427	.2317	.7	4.315	.1303	.7	7.674
.7244	.8	1.380	.4074	.8	2.455	.2291	.8	4.365	.1288	.8	7.762
.7161	.9	1.396	.4027	.9	2.483	.2265	.9	4.416	.1274	.9	7.852
.7079	3.0	1.413	.3981	8.0	2.512	.2239	13.0	4.467	.1259	18.0	7.943
.6998	.1	1.429	.3936	.1	2.541	.2213	.1	4.519	.1245	.1	8.035
.6918	.2	1.445	.3890	.2	2.570	.2188	.2	4.571	.1230	.2	8.128
.6839	.3	1.462	.3846	.3	2.600	.2163	.3	4.624	.1216	.3	8.222
.6761	.4	1.479	.3802	.4	2.630	.2138	.4	4.677	.1202	.4	8.138
.6683	.5	1.496	.3758	.5	2.661	.2113	.5	4.732	.1189	.5	8.414
.6607	.6	1.514	.3715	.6	2.692	.2089	.6	4.786	.1175	.6	8.511
.6531	.7	1.531	.3673	.7	2.723	.2065	.7	4.842	.1161	.7	8.610
.6457	.8	1.549	.3631	.8	2.754	.2042	.8	4.898	.1148	.8	8.710
.6383	.9	1.567	.3589	.9	2.786	.2018	.9	4.959	.1135	.9	8.811
.6310	4.0	1.585	.3548	9.0	2.818	.1995	14.0	5.012	.1122	19.0	8.913
.6237	.1	1.603	.3508	.1	2.851	.1972	.1	5.070	.1109	.1	9.016
.6166	.2	1.622	.3467	.2	2.884	.1950	.2	5.129	.1096	.2	9.120
.6095	.3	1.641	.3428	.3	2.917	.1928	.3	5.188	.1084	.3	9.226
.6026	.4	1.660	.3388	.4	2.951	.1905	.4	5.248	.1072	.4	9.333
.5957	.5	1.679	.3350	.5	2.985	.1884	.5	5.309	.1059	.5	9.441
.5888	.6	1.698	.3311	.6	3.020	.1862	.6	5.370	.1047	.6	9.550
.5821	.7	1.718	.3273	.7	3.055	.1841	.7	5.433	.1035	.7	9.661
.5754	.8	1.738	.3236	.8	2.090	.1820	.8	5.495	.1023	.8	9.772
.5689	.9	1.758	.3199	.9	3.126	.1799	.9	5.559	.1012	.9	9.886
									.1000	20.0	10.000